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ABSTRACTS FROM ASTRONOMICAL PUBLICATIONS.

In accordance with a recent arrangement the members of the scientific staff of the Lick Observatory hold meetings once per week, as an observatory duty, to report upon and discuss the more important articles appearing in the journals of astronomy, the important new books on astronomical subjects, or subjects of current and special interest in the observatory's work. It has been suggested that abstracts of the reports would be of interest to the readers of these Publications, and the Publication Committee has acted favorably upon the suggestions.

It is intended to preserve the qualities of abstracts as far as possible, and to restrict published criticisms, favorable or unfavorable, to a minimum.

INVESTIGATION OF ECLIPSING BINARIES, BY RUSSELL AND SHAPLEY.[1]

BAUSCHINGER remarks in his *Bahnbestimmung* that the relation between magnitudes, size, luminosities, and elliptic and photometric elements of eclipsing binaries are too complicated for a general theory. It is our purpose to show how far the problem is determinate and to develop formulæ and tables for determinate cases. In the most general case the relative orbit will be eccentric, and the two component masses will differ in size and brightness. The bodies may be elongated by mutual attraction, partially brightened by mutual illumination, or apparently darkened toward the limbs of the disks. There will be at least thirteen quantities to be determined—semi-major axis, eccentricity, inclination, longitude of periastron, period, epoch, two radii, two luminosities, ellipticity, reflection, and limb-darkening factors. The last mentioned may be deferred for special investigation. Two of the quantities depend upon the parallax, two upon inspection of the light-curve, and two upon particular photometric measures. Six remain to be determined by formulæ and constants of the light-curve.

The discussion is divided into several parts: First, solution for spherical stars and circular orbits; second, the corresponding tables; third, eccentric orbits; fourth, ellipticity of the stars; fifth, reflection, limb darkening, and densities.

The simplified problem discussed in the first part is stated as follows:—

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[1] Abstract from the *Astrophysical Journal*, **35**, 315, **36**, 54, 133, 239, 269, 385.

Two spherical stars, appearing as uniformly illuminated disks, and revolving about their common center of gravity in circular orbits, mutually eclipse one another. It is required to find the relative dimensions and brightness of the two stars, and the inclination of the orbit, from the observed light-curve.

Under these conditions, the two minima of the light-curve will be symmetrical and separated by exactly half the period; a total or annular eclipse produces a constant phase at minimum; the two minima will be of equal duration, but usually of unequal depth; the deeper minimum corresponds to the eclipse of the star which has the greater surface intensity by the other.

The discussion now distinguishes two cases—that of central eclipse giving constant phase at both primary and secondary minima, and that of partial eclipse giving no constant phases. In concluding the discussion of the first case, it is remarked that the method of solution is direct and simple, involving a very moderate amount of numerical work; the light-curve may be found without the necessity of computing the elements, and with two or three trials may be determined so as to represent the whole course of the observations, making the laborious solution by least squares superfluous except in the case of observations of unusual precision. Such a solution itself is much simplified if the constants defining the light-curve, instead of the elements of the system, are treated as the fundamental unknowns, as the coefficients of the equations of condition may be easily found graphically with the aid of data already computed. The elements may be found, at any stage of the process, by a few moments' calculation from the constants defining the light-curve.

In passing to the second case, which concerns partial eclipse, the previous methods cannot be used, and the following conclusion is reached: To the degree of approximation attained by any existing photometric measures, the problem of determining the elements of an eclipsing variable solely from the light-curve of a primary minimum without constant phase is indeterminate. Two of the required quantities cannot be rigorously deduced.

However, an equation is derived which, though not rigorously exact, must be very nearly satisfied in the case of all light-curves arising from partial eclipse. Having given any observed light-curve, the values of the coefficients may be determined in the manner described (omitted in this abstract), and a theoretical light-curve be found which closely represents the whole course of the observations. Knowledge of this light-curve, however, does not enable us to find the elements, but only a relation between them. Unless the secondary minimum has been observed, we can go no farther. But if we know the brightness at both minima, we have another relation or equation. Solution of these two equations gives the two required quantities,—namely, the ratio of the radii and the percentage of maximum eclipse.

When both minima are of very small depth, the indeterminate character of the solution is pronounced. The exact form of the light-curve for a shallow minimum is especially difficult to fix by observation. It follows that eclipsing variables of small range, such as have been recently discovered with the selenium photometer, present a problem which can be solved only by the addition of other data than those derivable from the light-curve. The ratio of the surface brightness of the components is the same as the ratio of loss of light at the two eclipses. This value in connection with an estimate from spectroscopic observation of the difference of magnitude of the components, determines the ratio of the radii. Whenever the latter quantity and the percentage of maximum eclipse have been found, the determination of the remaining elements is simple.

The above method of solution of the problem presented by a partial eclipse, though not rigorously exact, is sufficiently accurate to be adopted as final, unless the observations are unusually numerous and precise. If it seems desirable to proceed farther, the light-curve, including both primary and secondary minima, should be computed from the assumed elements. If it does not represent the observations sufficiently well, the assumed constants may be varied until satisfactory. As before, the elements need not be computed until a satisfactory light-curve has been found.

The second part of the investigation contains tables and explanations. Since the majority of eclipsing binaries have practically circular orbits, the above methods and tables will be more frequently used than those of the other parts of the discussion. The former have been applied to the eclipsing variables W *Delphini,* W *Ursæ Majoris,* and W *Crucis,* and the results are summarized as follows:[1] The light-curves shown in the figures are simply graphical representations of the tables. The curves are in all cases those corresponding to the finally adopted elements. The agreement between theory and observation is excellent. The "rectified" light-curves show how a curve of the *β Lyræ* type is transformed into one of the ordinary *Algol* type by the application of the correction for the ellipticity of the stars. (The latter process is developed in Part IV.)

The third part considers eccentric orbits. Analogy with orbits of spectroscopic binaries of similar period leads us to expect that the actual orbits of eclipsing variables will often show eccentricity. This is confirmed in several cases by displacement of the secondary minima from the position midway between the primary minima. Elements computed from the light-curve on the assumption of a circular orbit will differ from the true values. But for small eccentricity simple equations can be found which express very approximately the relation between the true and computed elements. In using these equations, since the secondary minima is often shallow, two cases occur, according as the principal minimum does or does not show a constant phase. In the first case the light-curve may be found which best represents the observations. Only the times of the four contacts need be computed at first and the work involved is small. If the principal eclipse occurs near periastron and is nearly grazing, the secondary eclipse may be partial. In the second case, with principal minimum showing no constant phase, the problem is more complicated, for two necessary quantities are unknown. But a certain sequence of operations starting with circular elements, may lead to acceptable values; if the range of values is wide, the problem is nearly indeterminate.

Part four deals with the ellipticity of the component bodies. *β Lyræ* is a classic example. The light changes are continuous and the brightness is greater between minima than before or after eclipse. This phenomena is reasonably explained by the assumption that the stars are elongated by their mutual attraction. The figure is probably nearly ellipsoidal. If the components are equal in mass and density, they will be similar in form. Two prolate spheroids is the basis of calculations in this investigation. (The methods of finding the ellipticity are explained.) Having found the ellipticity, the light-curve may be "rectified," i. e. the apparent influence of ellipticity may be removed. The procedure is then the same as for spherical bodies. When the orbit is eccentric, complications ensue, but a good approximation may be obtained by neglecting certain irregularities and proceeding as above.

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[1] *Astrophysical Journal,* **36**, 133.

The fifth part discusses mutual reflection of the two components, the darkening toward the limb of a disk and the densities of the bodies. It is improbable that the bodies appear as uniformly illuminated disks of constant surface brightness. It is likely that they appear, like the Sun, to be brighter at the center than at the limb and that each star is brighter on the side which is heated up by its companion's radiation. Direct evidence of the last phenomenon has been found in *Algol,* RT *Persei,* and Z *Draconis.* Few stars have been studied as carefully as these, but sufficiently accurate observations may show the phenomenon to be general.

Certain relations are available for freeing the light-curves from the effects of reflection so that it may be discussed as usual. Prolateness of the bodies complicates the expressions; but the curve may first be "rectified" to remove effects of ellipticity. The effect of eccentric orbit may be represented by a simple harmonic term in connection with "reflection.."

The densities of the component bodies cannot be computed unless the ratio of masses is known. This can be found in cases of double spectra, and otherwise. The densities are then expressed in terms of the mass-ratio, the period, and the radii.

The actual law of darkening toward the limb is unknown, but one may be assumed,—for instance, that applied to the Sun by SCHWARZSCHILD. Solution can be obtained by means of further tables. They will be twice as extensive as those already given, since the light-curves of annular and total eclipse differ with non-uniformly illuminated disks. The relations already developed for the case of partial eclipse may or may not be applicable. Ellipticity with darkening complicates the problem. The darkening should be greater when we see the prolate spheroid end on, than when it is side on. The variation in light will be increased and the ellipticity computed on the assumption of uniform surface brightness will be too great.

The darkening toward the limb has been further discussed in later papers[1] and the tables constructed. They enable the solutions to be made as easily as in the case of uniformly illuminated disks, provided the eclipse is total. The formulæ and tables are applicable only in those cases where there is a constant phase at minimum and the eclipsing star is the larger. But other methods are available for partial eclipses. The tables have been applied to the totally eclipsing variables W *Dephini,* S *Cancri,* SW *Cygni,* and U *Cephei.*[2] Solutions have also been made with the tables for uniformly illuminated disks. The conclusion is that the former results are more satisfactory, indicating that darkening at the limb exists in stars of spectral class A, but the difference in the curves is too small to determine the amount of darkening, even with the best existing photometric observations.

The discussion of annular and partial eclipses in connection with darkening of the limb has involved much labor. The light curves for non-central eclipse may be derived from that for central eclipse. Since annular and partial eclipses cannot be distinguished by inspection of the light-curves, they are discussed together for the determination of the elements.

A summary of the eclipsing-variable theory here developed is given at the end of the series of papers. The methods will probably be of use for many years to come in the practical solution of this problem.

G. F. Paddock.

The Brightness and Temperature of Stars.

Two essential problems in astrophysics are the determination of the brightness and of the temperature of stars, because of their concern with the sequence and transition of spectra. The question is, Which is the hotter and brighter—the blue, yellow, or red star? Investigations have usually been based upon inferences and assumptions, but there are certain cases in which the luminosity can be definitely computed. From the relations of stellar light and magnitude, is deduced the equation—

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[1] *Astrophysical Journal,* **36**, 239, 385.

[2] *Astrophysical Journal,* **36**, 269.

$$\pi R\sqrt{l} = 10^{-\frac{m+0.24}{5}}$$

in which π is the parallax, R the radius, m the magnitude, and l the intrinsic luminosity or brightness of a star whose radius equals the Sun's radius. Observations of eclipsing binaries determine the radii of the components, particularly when both components are luminous and give both primary and secondary light minima. If the system gives double spectra, the parallax is thence determined, and l is then found by means of the above equation. Without double spectra, but with a correspondence of spectra and luminosity with the Sun or other known body, the parallax may possibly be determined by the above equation. This, however, will be a rare case. It is likely that the parallax will be known for numerous stars in the future. Hence l, the star's intrinsic luminosity, will be the quantity actually to be sought by means of the above equation. Photometric observers are finding that numerous variables have double minima. The combination of photometric and spectrographic observations and elements is needed for as many stars as possible.

Temperatures can hardly be determined unless we know or assume a law of relation between l and T (absolute temperature). However, formulæ representing these laws have been derived for the theoretical perfect radiator under terrestrial or laboratory conditions, and several attempts have been made to apply the formulæ to star light. WILSING, SCHEINER, SCHWARZSCHILD, NORDMAN, and ROSENBERG have published series of relative temperatures for the bright stars. Each work is based upon measures of difference of intensity of red, yellow, and blue light received from stars. The difference of intensity has been measured either by photometer and photograph, or from spectrum photographs. An adaptation of PLANCK's radiation formula,—

$$E = \frac{C_1}{\lambda^5\left(e^{\frac{C_2}{\lambda T}} - 1\right)}$$

which expresses the radiated energy E as an exponential function of wave-length λ and absolute temperature T then gives values for T corresponding to each stellar measure. The most recent results are those of Rosenberg[1] derived from Göttingen observations with a prismatic camera of the seventy brightest northern stars. His results differ only in a definite ratio from those of Wilsing and Scheiner.

The stellar measures are expressed in differences of magnitude and reduced to a basis of zero difference for the Sun spectrum. The derived temperatures are relative to the Sun's temperature of about 5000° (absolute), which has been derived by Planck's formula from Abbot's bolometer measures of the Sun's spectrum intensities and Paschen's constants of a perfect radiator. The results for some of the conspicuous stars are: *Sirius,* 27,000°; *Vega,* 22,000°; *Algol,* 12,000°; *Altair,* 10,000°; *Procyon,* 7,000°; *Polaris,* 5,000°; *Capella,* 4,500°; *Arcturus,* 3,000°; *Betelgeuze* and *Aldebaran,* 2,000°. Rosenberg has plotted the reciprocals of his temperatures against the series of classes of spectra as defined by Miss Maury and by Vogel. The plots show that there are more differences of spectrum among the highest and lowest temperatures than among the intermediate temperatures. The general results of the investigation are that the helium stars are the hottest, and the reddest stars of banded spectra the lowest in temperature. In other words, the derived sequence of temperatures follows the sequence of spectral class. G. F. Paddock.

March, 1913.

On the Spectrum of the Nebula in the Pleiades, by V. M. Slipher.[2]

Since its discovery by Temple in 1859, the *Merope* nebula has been an object of unusual interest to astronomers. In the telescope it is so faint and diffuse that in the old days, before the advent of the camera as an aid to the astronomer, its existence was disputed and held in grave doubt by many observers. In fact, a number of the profession may be said to have been divided into hostile camps on this question, and in the skirmishes which resulted the pages of astronomical periodicals were occasionally enlivened by passages which broke through that cold formality which is supposed to mark the expression of scientific opinion. Happily those strenuous days are now past. Among the early achievements of the photographic plate was the proof, satisfactory to the most skeptical, that the nebula is there, a bundle of interlacing wisps weaving together the entire group of the *Pleiades*, and pointing to the close physical connection of the members of this group of stars. Curiously enough, the camera, in confirming TEMPLE's discovery, proved as well that his idea of the nebula was, in one respect, quite erroneous. He observed the nebula only close to and to the south of *Merope*. GOLDSCHMIDT in 1864 described the cosmical cloud as surrounding the whole group of the *Pleiades*. Commenting on this observation, Professor TEMPLE remarked: "But this is an optical illusion, and in another letter I shall, with your permission, proceed to prove this by the description of a false image in the telescope, a curious phenomenon hitherto unexplained." GOLDSCHMIDT's remarkable observation is of course amply confirmed by photography.

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[1] *Astronomische Nachrichten,* **193**, 358, 1913.

[2] *Lowell Observatory Bulletin,* **2**, 26, 1912.

We must ask the indulgence of the reader for this somewhat extended excursion into a phase of the history of this nebula which has no direct bearing on the subject-matter of the article under review, but we offer in extenuation of our garrulity the fact that we have called attention to the doubt and uncertainty with which this nebula was for years regarded, a view-point quite in keeping with the mystery which has attached itself to the *Pleiades* group, among races civilized and savage, since before the beginnings of history. We may therefore regard it as a professional practice backed by precedent to accept with caution, until fully confirmed, discoveries associated with this cluster.

Dr. SLIPHER's paper deals with a photographic observation of the spectrum of the nebulous filaments near the star *Merope*. Two spectrograms were secured with a spectrograph attached to the 24-inch refractor of the Lowell Observatory. The first exposure was of five hours' duration and the second of twenty-one hours. The slit was located in the one case about 1½′ of arc south of the star and in the other 3′ northeast, the orientation being east and west for both observations. The discussion is based on the second spectrogram secured. We can do no better than to quote Dr. SLIPHER's description of this plate.

"The second spectrogram, while not strong, contains a perfectly legible record. It is a continuous spectrum crossed by strong hydrogen lines—$H\beta$, $H\gamma$, $H\delta$, $H\epsilon$, and $H\zeta$ showing, and fainter helium lines, those at 4026, 4381, and 4472 (combined with 4481), being recognizable. It contains no traces of the bright lines found in the spectra of gaseous nebulæ. The hydrogen lines are much more prominent than are the helium lines, and the whole spectrum is a true copy of the brighter stars of the *Pleiades*."

To satisfy himself that the recorded spectrum did not have its origin in light from *Merope* scattered in his telescope, Dr. SLIPHER made an equivalent exposure close to *Sirius*, and finding no disturbing factor, assumed the plate record to represent the spectrum of the *Pleiades* nebula. A further confirmation of this view he finds in the fact that the spectrum is not uniform over its full breadth, but fades suddenly at one edge, as though the slit had projected beyond the bright part of the nebula.

Upon the basis of this spectrogram the author indulges in some speculations, throwing out the suggestion that the light of the nebula may be diffused starlight, originating with *Merope*. In other words, the nebula does not shine by its own light, but is an aggregation of non-luminous material *lighted up* by *Merope* and other stars of the *Pleiades* group. Dr. SLIPHER's figures show that, in the part of the nebula which he observed, *Merope* would appear as a star of about — 11 magnitude, and *Alcyone* two or three magnitudes fainter; that is, the former would be about as bright as the full Moon. As it is easy for us to see thin clouds by moonlight, there can hardly be any criticism of this theory on the basis of insufficiency of illumination. Dr. SLIPHER's explanation parallels exactly the theory of the nebulosity surrounding *Nova Persei* proposed by SEELIGER, KAPTEYN, W. E. WILSON, and others.

Dr. SLIPHER's paper is interesting and suggestive, and his audacity in attempting this observation must win the admiration of his colleagues, but we believe that astronomers will await his confirmation of these preliminary results before making them the basis of extended speculations. Unfortunately, the constants of his spectrograph are not explicitly stated, so that we are unable to judge of its efficiency for observations of very faint spectra. Few persons unfamiliar with spectroscopic observation fully appreciate the extreme faintness of the spectrum of an object of this class and the resulting difficulties of observation. W. H. WRIGHT.

ON THE SHORT-PERIOD VARIABLE, SU DRACONIS, BY C. MARTIN AND H. C. PLUMMER.[1]

This star was selected for observation in order to test the reality of certain secondary fluctuations which had been encountered in the course of the work with the Dunsink 15-inch reflector. The method employed was to give a long exposure in the region of the variable star, getting images with sensible discs, the inner nuclei of which were measured with the micrometer. Sixty-seven measurable exposures were made, extending over a period of about two months. It was found that the relation between magnitude and diameter for the Dunsink reflector could be expressed by $m = a - b\,D^{2/3}$. By plotting m (magnitude) and $D^{2/3}$ (diameter) for the standard stars chosen in the neighborhood of SU, and drawing a straight line through the points, m could be read off corresponding to the measured $D^{2/3}$ of the variable. From the maximum of this series combined with that found by Professor SEARES in 1908, the value of the period was found to be $0^{d}.6604347$. When the observations were plotted it was seen that there was, besides this period, a secondary variation in about one-sixth the time. Attempts to determine this sub-period were unsuccessful. By spherical harmonics, the following analytic expression was derived, which represents the observations very closely: $m = 10.02 + .34 \sin (\theta + 239^\circ.9) + .19 \sin (2\theta + 271^\circ.9) + .15 \sin (3\theta + 301^\circ.6) + .05 \sin (4\theta + 345^\circ.4) + .03 \sin (5\theta + 166^\circ.0) + .06 \sin (6\theta + 11^\circ.7) + .03 \sin (7\theta + 267^\circ.8) + .02 \sin (8\theta + 244^\circ.0) + .02 \sin (9\theta + 236^\circ.8) + .01 \sin (10\theta + 236^\circ.7) + .01 \sin (11\theta + 146^\circ.0)$. A comparison of curve and observation led to the conclusion that the error of observation was probably less than ± $0^m.03$. The general characteristics of the visual and photographic results are the same, but details differ considerably in the two methods. A. M. HOBE.

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[1] *Monthly Notices*, January, 1913.

COMPARISON OF OBJECTIVE PRISM AND SLIT SPECTROGRAMS,

BY ANNIE J. CANNON.[1]

The object of this paper was to see whether or not there would be any differences in classifying slit spectrograms and objective prism photographs. For this purpose spectrograms were obtained from Yerkes, Lick, and Allegheny observatories. These spectrograms, of all types of stars, were classified independently, all identifying marks being concealed, and the results compared with the Harvard objective prism classification. A list, classified by Dr. KOHLSHÜTTER, was also sent from Mount Wilson and these Miss CANNON compared in the same way. The Yerkes were one-prism plates and included the same part of the spectrum as the objective prism. The Lick were three-prism plates and gave too great a dispersion for general purposes of classification, but were splendid for getting relative intensities of lines. The Allegheny were one-prism plates and were excellent for general classification, but did not show the faint, hazy, dark lines so clearly as the objective prism. The general conclusion was that there were only slight differences between the objective prism and slit-spectrogram classifications, the tendency being to put the slit spectrograms a little later in the scale. A. M. HOBE.

VOLUME XX OF THE ARGENTINE NATIONAL OBSERVATORY AT CÓRDOBA.

This publication contains the results of the meridian circle observations which were made in the years 1885 to 1890, inclusive, under the direction of the late Dr. J. M. THOME, and which were reduced under his supervision.

The catalogue includes 5.791 stars, all of which, with the exception of sixty-eight, are south of the equator. The list includes the 303 stars which make up the fundamental catalogue for the southern Gesellschaft zones. Observations of the greater part of the bright stars were included in the *Argentine General Catalogue,* Volume XIV, of the same observatory. The faint stars of this later catalogue were mostly observed as part of a scheme to provide a network of star places, one every 10′ of declination, at intervals of two minutes of right ascension. Sufficient stars do not exist, of the brightness possible to observe with the original meridian circle at Córdoba, to complete such a design. The *Zone Catalogue,* though giving fairly good distribution, leaves some gaps, most of which, however, it would not be possible to fill with available stars.

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[1] *Annals of Harvard College Observatory*, Vol. LVI, No. VIII.

The catalogue includes the fundamental stars used for clock errors and for the determinations of azimuth. It contains reference, by numbers, to the *General Catalogue* and the *Zone Catalogue* of Córdoba, and to the several parts of the visual and photographic *Durchmusterung* of the southern sky. For the brightest stars, those designated by letters in the constellations, no references are given. For many of these bright stars, more than one value of the magnitude has been printed, though the practice usually followed has been to give the magnitude adopted by some standard authority. The *Uranometry* affords such a standard, and certainly none of the estimates of bright stars made by meridian-circle observers can be considered as trustworthy in comparison with it.

The improvement in the financial condition of the country, and a more liberal policy to the observatory on the part of the government, have finally remedied the delay in the publication of these observations, made more than twenty years ago. Of the men attached to the observatory at that epoch, JOHANN DREESSEN is the only member of the present staff.

March 10, 1913. R. H. TUCKER.

"EXTRA-MERCURIAL" PLANETS.

A great deal has been written on BODE's well-known law of planetary distances, but it is doubtful if a more novel aspect of the law has ever been developed than that which is given by Professor C. V. L. CHARLIER in his paper, "Das Bodesche Gesetz und die sogenannten intramerkuriellen Planeten." [1]

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[1] *Astronomische Nachrichten,* **193,** 269, 1913.

This law of planetary distances is regarded by most astronomers as simply a curious coincidence, but POINCARÉ has shown that the law prescribes that the planets were separated from the original solar nebula at equal intervals of time, so that there is the possibility that such a law might have a real mechanical significance. Why the planets should have separated at equal intervals of time, however, remains without explanation.

As ordinarily written, the law of BODE is derived as follows: Writing down the progression 0, 3, 6, 12, etc., and then adding the constant quantity, 4, the resulting quantities will give the relative distances of the planets from the Sun; to obtain these distances in terms of the Earth's distance, the values may be divided by 10.

	0	3	6	12	24	48	96 etc.
Adding 4	+4						
Divide by 10...	0.4	0.7	1.0	1.6	2.8	5.2	10.0 etc.

This gives 0.4 for *Mercury's* distance, unity for that of the Earth, and holds well for all the planets except *Neptune*.

Now it has ordinarily been assumed that to obtain the probable distance of an intra-mercurial planet, by means of BODE's law, the series should be extended to the left by the addition of a term, —3, giving 0.1 for the relative distance of such a body. But, as pointed out by GAUSS, if this were a true geometric progression the first term should be 1.5 instead of 0, and CHARLIER gives for the mathematical expression of BODE's law the following formula:—

$$\text{Distance} = 0.4 + 0.3 \times 2^{n},$$

where n is a whole number. The value $n = 1$ gives the Earth's distance, $n = 0$ that of *Venus*, while for the distance of *Mercury* $n = -\infty$. According to this formula, then, there would possibly exist between *Venus* and *Mercury* an infinite number of planets, with the distances,—

0.550, 0.475, 0.438, 0.419, 0.409, 0.405, 0.402........0.400

This *Saturn*-like ring of small bodies, with its inner limit at the mean distance of *Mercury*, would not be equally distributed, but the majority of these planetoids should be found at the two libration points which make equilateral triangles with

Mercury and the Sun. Such a ring of planetoids would serve to clear up the discrepancies in the motion of the perihelion of *Mercury*. CHARLIER applies a similar formula to the satellites and rings of *Saturn*. He points out that such bodies as these planetoids could best be searched for at the time of a total solar eclipse, though it should be possible to institute such a search in stations near the equator at any time.

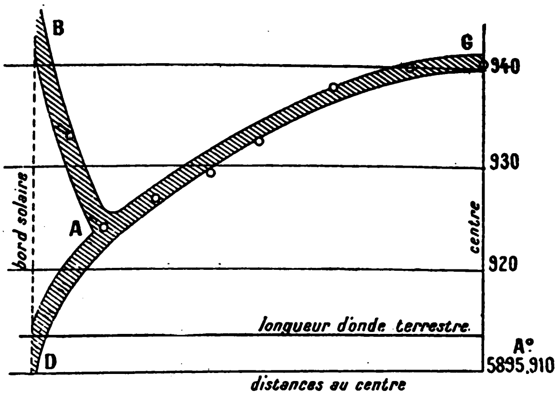
H. D. CURTIS.

March, 1913.

A. PEROT: WAVE-LENGTH OF SOLAR D_1.[1]

In a former paper it was shown that near the center of the Sun the b_2 line of magnesium has a velocity of $+ 1.57^{\text{km}}$ per second, indicating that the absorbing magnesium is falling in toward the center of the Sun. It was suggested that this may be due to the fall of particles of negative electricity which may drag the absorbing atoms along with them.

The wave-length of D_1 was measured by interference methods at different points along a line from the north to the south pole of the Sun and bisecting the apparent disk. At the center of the Sun, G in the figure, the wave-length is 5895.941 Ångstroms; it decreases as we go outward along the radius toward the pole, until about 60° of latitude, A, where, due to tangential effect, other than rotation, the curve reverses, and the wave-length increases on to the pole B. Neglecting the tangential effect and continuing the first portion of the curve as a smooth



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[1] *Comptes Rendus*, **154**, 326, 1912.

sweep down to D, it gives the wave-length at the edge as 5895.914, corresponding to a difference of 1.37^{km} from the center. The wave-length of bright D_1 as measured in a laboratory flame is 5895.930. The flame *absorption* D_1 was measured and found to be 5895.9155, which agrees within experimental errors with the extrapolated value for the Sun's limb.

P. W. MERRILL.

UPON THE DEPENDENCE OF THE DISTRIBUTION OF STARS OF DIFFERENT SPECTRAL TYPES, AND OF THE MEAN PARALLAXES OF THE STARS UPON THE GALACTIC LATITUDE.

Under this title (in German) Professor H. SEELIGER publishes in the *Astronomische Nachrichten*[1] the general conclusions arrived at in a research upon stellar distribution. The detailed results will be published later, probably in the Proceedings or Transactions of the Munich Academy of Sciences, which contain his three earlier papers on the same general subject.

Referring to these earlier researches, Professor SEELIGER says that in the formulæ he derived for the numbers of stars of given apparent magnitude and for their mean distances the facts that the stars are not uniformly distributed in space and that they are not all of the same luminosity (*Leuchtkraft*) have been taken into account with their proper weights. "That thereby," he adds, "the correct foundations for all stellar astronomical researches have been formulated cannot be gainsaid."

The present paper refers to a study of what SEELIGER calls the "typical" stellar system (i. e. one which assumes that the plane of the Milky Way is the plane of symmetry in the system), and investigates the dependence, if any, of the distribution of the stars of different spectral types, of their mean parallaxes, etc., upon the galactic latitude, or, in other words, upon their distance from this fundamental plane. His earlier formulæ, referred to above, gave expressions for a function $\phi(\iota)$, and for D, in which ι represents the relative frequency of the various apparent stellar magnitudes if all of the stars were at the same distance from us,[1] and D, the density of star distribution in a unit volume of space.

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[1] *Astronomische Nachrichten*, **193**, 161, 1912.

By the use of these two formulæ, with proper choice of the variables and constants involved, SEELIGER finds that he can represent quite approximately the distribution of the stars of different spectral types to magnitude 6.25 tabulated by PICKERING from actual count on the Draper memorial photographs. He also finds that, by a similar process, he can reproduce, in a general way, the average radial velocities given by CAMPBELL for stars of different spectral type. Investigating the mean parallaxes of the stars of a given magnitude with the aid of these formulæ, he concludes that the parallaxes increase as we proceed from the pole to the plane of the Milky Way, so that, for example, the average star of 8.5 apparent magnitude in the Milky Way is 2.34 times as distant as one of the same magnitude at its pole.

SEELIGER's general conclusions are that the Milky Way is a fundamental part of the structure of the entire stellar system and that this system is limited in extent (conclusions already arrived at in his earlier researches); that the function $\phi(\iota)$ has the same form in all parts of the stellar system, and, finally, that the correspondences now developed confirm, so far as they go, the validity of his formulæ. R. G. AITKEN.

March 10, 1913.

SUR LES SPECTRES DES NÈBULEUSES ET SUR LES ANALOGIES QU'ON EN PEUT TIER. NOTE DE M. JEAN MEUNIER, PRESENTÍE PAR M. ARMAND GAUTIER.[2]

This article represents an attempt to correlate the spectra of the nebulæ with the dark-line spectrum of the Sun. As a basis for the comparison, the author offers on the one side a list of eight nebular lines, gleaned from some casual remarks on the spectra of the nebulæ in the *Annuaire du Bureau des Longitudes*. The selection of lines is unfortunate, as it includes some of the fainter of the fifty or more well-known nebular lines and omits many of the stronger. One of them, 4481 A, does not appear in those numbers of the *Annuaire* which we have consulted, and such a line has not, to our knowledge, been observed in a nebula. The treatment of the subject has the merit of originality, but evidences so limited an acquaintance with the subject of astronomical spectroscopy as hardly to call for serious criticism. For instance, one is accustomed to regard the existence of helium in the nebulæ as proved by the exact coincidence of the principal lines of its spectrum with lines in the spectra of the nebulæ, but M. MEUNIER completely ignores the claims of this element, and identifies the nebular lines in question with iron lines four or five Ångstroms away. We fear that the paper will not carry much weight with the working spectroscopist, and, as we have said, it seems to have few claims to serious consideration. It is reviewed chiefly for the purpose of calling attention to the danger which attends the publication of ill-considered articles by a journal having the prestige of the *Comptes Rendus* of the Paris Academy. Persons unfamiliar with certain phases of astrophysics might well be led astray in their notions of the present state of the science.

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[1] SEELIGER takes this unit distance as the one expressed by the stellar parallax 0″.2 and calls it "*Siriusweite*," though the best value of the parallax of *Sirius* is 0″.38.

[2] *Comptes Rendus*, **156**, 391, 1913.

W. H. WRIGHT.

March, 1913.

THE USE OF GALACTIC CO-ORDINATES FOR THE FIXED STARS.

Mr. INNES devotes Circular No. 2 of the Union Observatory[1] of South Africa to an argument in favor of the use of galactic co-ordinates in defining a star's position in the sky instead of the usual equatorial co-ordinates, right ascension and declination. The advantages to be gained are:—

"(1) The place of any star in any catalogue will only differ from [that in] another catalogue by errors of observation and by proper motion, therefor catalogues will be comparable without preliminary calculation.

"(2) The reduction to apparent place, and vice versa, is shorter than the present method.

"(3) The stars are referred to their natural plane of reference and facts of stellar distribution and drift, which are at present hidden, are at once recognized."

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[1] As a consequence of the political reorganization of the English provinces of South Africa, the Transvaal Observatory has become the Observatory of the Union of South Africa. Mr. R. T. A. INNES continues in charge as director, and his address is Johannesburg, Transvaal, Union of South Africa.

Taking for the position of the galactic pole the co-ordinates given by NEWCOMB: R. A. = 191°.1; Decl. = + 26°.8, and for the solar apex the position suggested by CAMPBELL as most convenient: R. A. = 270°; Decl. = + 30°, and assuming the point of departure for galactic longitudes to make the longitude of the solar apex 0°,—INNES gives the formulæ, with illustrative examples and specimens of tables, for all the cases arising in the conversion of co-ordinates from one system of reference to the other.

Notes in this department of the *Publications* are designed to be abstracts merely, and, in general, to omit criticism, but I think it may be permissible to add that, though there are many obvious objections to it, there is also much to be said in favor of such a change as Mr. INNES suggests. He quotes Professor TURNER'S statement, made in 1843—"Right ascension and declination are a necessity of meridian and equatorial observations, but only complicate any discussion of the places of the stars." It would be easy to get similar opinions from all astronomers who have engaged in investigations of stellar motions. As a matter of fact, a considerable part of the computation involved in such researches as those published in recent years by KAPTEYN, BOSS, CAMPBELL, and others has consisted in the conversion of the star places used from equatorial to galactic co-ordinates. R. G. AITKEN.

March, 1913.

DISTRIBUTION OF THE SPECTROSCOPIC BINARY STARS.

It has been shown that seventy-four of the ninety-three known *Algol*-type variable stars are found within 30° of the plane of the Milky Way. This condensation toward the Milky Way is more than twice as great as that shown by the stars to the ninth magnitude taken as a whole. The *Algol* variables are all supposed to be spectroscopic binaries, though at present only the brighter ones have been observed for radial velocity. M. P. STROOBANT has now investigated the distribution of the 306 spectroscopic binary stars included in CAMPBELL'S Second Catalogue, to determine whether a similar tendency is shown by them. His results are printed in the *Comptes Rendus*, Paris Academy,[1] and may be summarized briefly as follows:

Two hundred and seventeen of these stars lie within 30° of the central plane of the Milky Way, but 108 of them are Class B stars. Since the known spectroscopic binaries are, with few exceptions, visible to the naked eye, we must compare this distribution with that of the naked-eye stars. Taking the latter from HOUZEAU, STROOBANT finds that 2,565 of the 5,719 lie within galactic latitude limits ± 30°. Stated as percentages, about 40 per cent of all naked-eye stars, about 71 per cent of all known spectroscopic binary stars, and about 55 per cent of the latter when the Class B stars are excluded, lie within 30° of the plane of the Milky Way. The observed condensation of the spectroscopic binaries toward this plane is therefore largely, but not wholly, due to the preponderance of the Class B binaries.

R. G. AITKEN.

March 13, 1913.

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[1] *Comptes Rendus,* **156,** 37, 1913.